

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
28 July 2005 (28.07.2005)

PCT

(10) International Publication Number  
WO 2005/069223 A3

(51) International Patent Classification<sup>7</sup>: G06T 7/60

(21) International Application Number:  
PCT/IL2004/001169

(22) International Filing Date:  
26 December 2004 (26.12.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/536,661 15 January 2004 (15.01.2004) US

(71) Applicant (for all designated States except US): ALGO-TEC SYSTEMS LTD. [IL/IL]; 2 Hapnina Street, 3rd Floor, 43107 Raanana (IL).

(72) Inventors; and

(75) Inventors/Applicants (for US only): MILSTEIN, Ido [IL/IL]; 11 Netef Street, 47226 Ramat Hasharon (IL).

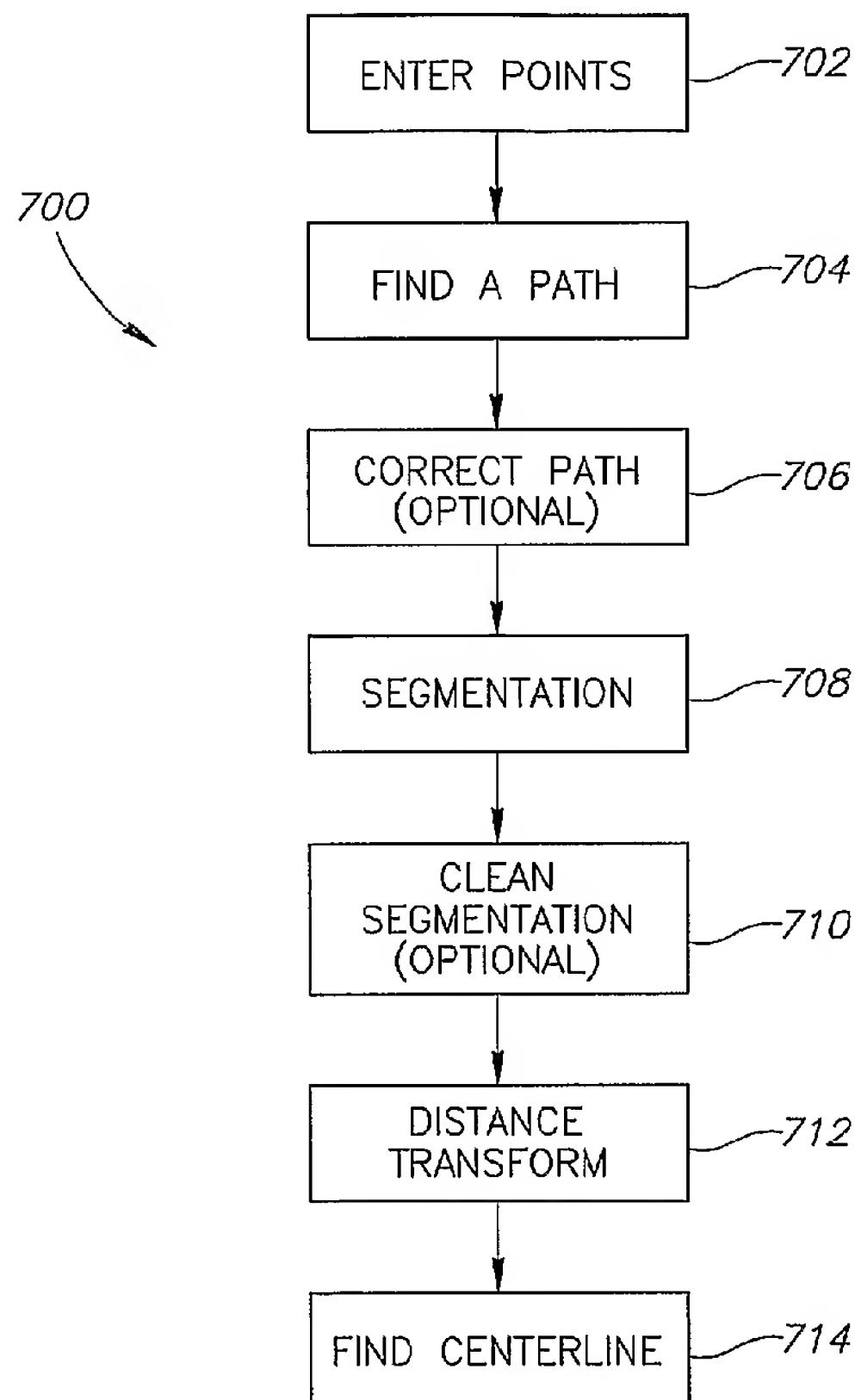
AKERMAN, Shmuel [IL/IL]; 34 Sheshet Hayamim Street, 30500 Binyamina (IL). MILLER, Gad [IL/IL]; 42940 Kfar Yedidya (IL). COHEN, Laurent [FR/FR]; 151 Avenue Achille Peretti, F-92200 Neuilly Sur Seine (FR).

(74) Agents: FENSTER, Paul et al.; FENSTER & COMPANY, INTELLECTUAL PROPERTY 2002 LTD., P. O. BOX 10256, 49002 Petach Tikva (IL).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

[Continued on next page]

(54) Title: VESSEL CENTERLINE DETERMINATION



(57) Abstract: A method of centerline determination for a tubular tissue in a medical image data set defined in a data space, comprising receiving at least one start point and one end point inside a tubular tissue volume; automatically determining a path between said points that remains inside said volume; automatically segmenting said tubular tissue using said path; and automatically determining a centerline for said tubular tissue from said segmentation, wherein said receiving, said determining a path and said segmenting, said determining a centerline are all performed on a same data space of said medical image data set.

WO 2005/069223 A3



(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) **Date of publication of the international search report:**  
15 December 2005

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/IL2004/001169

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 G06T7/60

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G06T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, IBM-TDB

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category <sup>a</sup>	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>LI R ET AL: "Combining front propagation with shape knowledge for accurate curvilinear modeling" MEDICAL IMAGE COMPUTING AND COMPUTER-ASSISTED INTERVENTION - MICCAI 2003. 6TH INTERNATIONAL CONFERENCE. PROCEEDINGS. PART II (LECTURE NOTES IN COMPUT. SCI. VOL. 2879) SPRINGER - VERLAG BERLIN, GERMANY, 2003, pages 66-74, XP002325788 ISBN: 3-540-20464-4 the whole document</p> <p>-----</p> <p>-/-</p>	1-72, 86-94

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

### <sup>a</sup> Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance  
"E" earlier document but published on or after the international filing date  
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)  
"O" document referring to an oral disclosure, use, exhibition or other means  
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone  
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.  
"&" document member of the same patent family

Date of the actual completion of the international search

28 April 2005

Date of mailing of the international search report

09.11.2005

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Herter, J

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/IL2004/001169

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SETHIAN J A: "Level set methods and fast marching methods" [Online] 1999, CAMBRIDGE UNIVERSITY PRESS , XP002325674 Retrieved from the Internet: URL: <a href="http://math.berkeley.edu/~sethian/Books/sethian_book.ps">http://math.berkeley.edu/~sethian/Books/sethian_book.ps</a> > [retrieved on 2005-04-20] the whole document -----	1-72, 86-94
A	DESCHAMPS T ET AL: "Fast extraction of minimal paths in 3D images and applications to virtual endoscopy" MEDICAL IMAGE ANALYSIS, OXFORD UNIVERSITY PRESS, OXFORD, GB, vol. 5, 2001, pages 281-299, XP002904305 ISSN: 1361-8415 the whole document -----	1-72, 86-94
A	COHEN L D ET AL: "GLOBAL MINIMUM FOR ACTIVE CONTOUR MODELS: A MINIMAL PATH APPROACH" INTERNATIONAL JOURNAL OF COMPUTER VISION, KLUWER ACADEMIC PUBLISHERS, NORWELL, US, vol. 24, no. 1, August 1997 (1997-08), pages 57-78, XP000703576 ISSN: 0920-5691 cited in the application the whole document -----	1-72, 86-94
A	WINK O ET AL: "3D MRA CORONARY AXIS DETERMINATION USING A MINIMUM COST PATH APPROACH" MAGNETIC RESONANCE IN MEDICINE, ACADEMIC PRESS, DULUTH, MN, US, vol. 47, no. 6, June 2002 (2002-06), pages 1169-1175, XP001170393 ISSN: 0740-3194 the whole document -----	1-72, 86-94
A	MADDAH MAHNAZ ET AL: "Efficient center-line extraction for quantification of vessels in confocal microscopy images" MEDICAL PHYSICS, AMERICAN INSTITUTE OF PHYSICS, NEW YORK, US, vol. 30, no. 2, February 2003 (2003-02), pages 204-211, XP012011984 ISSN: 0094-2405 the whole document -----	1-72, 86-94

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IL2004/001169

### Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3.  Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-72, 86-94

Remark on Protest

The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-72,86-94

centerline finding for a tubular tissue in a medical image data set

---

2. claims: 73-80

segmentation of an organ in a medical data set

---

3. claims: 81-85

propagation fo a parametrization in a medical data set

---